**WHAT IS CLAIMED IS:**

1. An isolated, modified human cystathionine-γ-lyase (CGL) enzyme comprising the following substitutions relative to a native human CGL amino acid sequence as shown in SEQ ID NO: 1, wherein the modified enzyme has both homocystinase and homocysteinase activity, wherein the modified enzyme comprises a sequence at least 95% identical to SEQ ID NO: 1, said substitutions comprising isoleucine at position 59, leucine at position 63, methionine at position 91, aspartic acid at position 119, arginine at position 268, glycine at position 311, valine at position 339, and serine at position 353.

2. The isolated, modified human cystathionine-γ-lyase (CGL) enzyme of claim 1, wherein the substitutions comprise E59I, S63L, L91M, R119D, K268R, T311G, E339V, and I353S relative to the native human CGL amino acid sequence as shown in SEQ ID NO: 1.

3. The isolated, modified human cystathionine-γ-lyase (CGL) enzyme of claim 1, wherein the modified human CGL enzyme has a sequence according to SEQ ID NO: 37.

4. The isolated, modified human cystathionine-γ-lyase (CGL) enzyme of claim 1, wherein the enzyme is coupled to at least one polyethylene glycol (PEG).

5. The isolated, modified human cystathionine-γ-lyase (CGL) enzyme of claim 4, wherein the enzyme is coupled to the at least one PEG via one or more lysine residues.

6. A therapeutic formulation comprising the isolated, modified human cystathionine-γ-lyase (CGL) enzyme of claim 1, in a pharmaceutically acceptable carrier.

7. The isolated, modified human cystathionine-γ-lyase (CGL) enzyme of claim 2, wherein the enzyme is coupled to at least one polyethylene glycol (PEG).

8. The isolated, modified human cystathionine-γ-lyase (CGL) enzyme of claim 7, wherein the enzyme is coupled to the at least one PEG via one or more lysine residues.

9. A therapeutic formulation comprising the isolated, modified human cystathionine-γ-lyase (CGL) enzyme of claim 2, in a pharmaceutically acceptable carrier.

10. The isolated, modified human cystathionine-γ-lyase (CGL) enzyme of claim 3, wherein the enzyme is coupled to at least one polyethylene glycol (PEG).

11. The isolated, modified human cystathionine-γ-lyase (CGL) enzyme of claim 10, wherein the enzyme is coupled to the at least one PEG via one or more lysine residues.

12. A therapeutic formulation comprising the isolated, modified human cystathionine-γ-lyase (CGL) enzyme of claim 3, in a pharmaceutically acceptable carrier.

13. A composition comprising the isolated, modified human cystathionine-γ-lyase (CGL) enzyme of claim 1, wherein the composition is at physiological pH.

14. The composition of claim 13, wherein the modified human CGL enzyme has the sequence of SEQ ID NO: 37.

15. The composition of claim 14, wherein the isolated, modified human cystathionine-γ-lyase (CGL) enzyme displays a $k_{cat}/K_M$ for the hydrolysis of homocysteine greater than the wild-type human CGL enzyme.

16. The composition of claim 14, wherein the isolated, modified human cystathionine-γ-lyase (CGL) enzyme displays a $k_{cat}/K_M$ for the hydrolysis of homocysteine of about 11.9 $s^{-1}mM^{-1}$ at pH 7.3 and 37°C.

17. The composition of claim 14, wherein the isolated, modified human cystathionine-γ-lyase (CGL) enzyme displays a $k_{cat}/K_M$ for the hydrolysis of homocysteine about 60-fold greater than wild-type human CGL.

18. The composition of claim 14, wherein the isolated, modified human cystathionine-γ-lyase (CGL) enzyme displays a $k_{cat}/K_M$ for the hydrolysis of homocystine of about 18.8 $s^{-1}mM^{-1}$ at pH 7.3 and 37°C.

19. The composition of claim 14, wherein the isolated, modified human cystathionine-γ-lyase (CGL) enzyme displays a $k_{cat}/K_M$ for the hydrolysis of homocysteine of about 11.9 $s^{-1}mM^{-1}$ at pH 7.3 and 37°C and displays a $k_{cat}/K_M$ for the hydrolysis of homocystine of about 18.8 $s^{-1}mM^{-1}$ at pH 7.3 and 37°C.

20. Use of the formulation of claim 6 in the manufacture of a medicament for treating a subject having or at risk of developing homocystinuria or hyperhomocysteinemia.

21. The use of claim 20, wherein the enzyme is coupled to at least one polyethylene glycol (PEG).

22. The use of claim 21, wherein the enzyme is coupled to the at least one PEG via one or more lysine or cysteine residues.

23. The use of claim 20, wherein the formulation is to be administered intravenously, intraarterially, intraperitoneally, intralesionally, intraarticularly, intraprostaticaly, intrapleurally, intratracheally, intravitreally, intramuscularly, intravesicularlly, intraumbilically, by injection, by infusion, by continuous infusion, by localized perfusion bathing target cells directly, or via a catheter.

24. The use of claim 20, wherein the subject has previously been treated for homocystinuria or hyperhomocysteinemia and the enzyme is to be administered to prevent the recurrence of homocystinuria or hyperhomocysteinemia.

25. The use of claim 20, further comprises at least a second homocystinuria or hyperhomocysteinemia therapy to be administered to the subject.

26. The use of claim 25, wherein the second homocystinuria or hyperhomocysteinemia therapy is a high-dose vitamin B6 or betaine (N,N,N-trimethylglycine) therapy.

27. Use of the formulation of claim 9 in the manufacture of a medicament for treating a subject having or at risk of developing homocystinuria or hyperhomocysteinemia.

28. The use of claim 27, wherein the formulation is to be administered intravenously, intraarterially, intraperitoneally, intralesionally, intraarticularly, intraprostaticaly, intrapleurally, intratracheally, intravitreally, intramuscularly, intravesicularlly, intraumbilically, by injection, by infusion, by continuous infusion, by localized perfusion bathing target cells directly, or via a catheter.

29. Use of the formulation of claim 12 in the manufacture of a medicament for treating a subject having or at risk of developing homocystinuria or hyperhomocysteinemia.

30. The use of claim 29, wherein the formulation is to be administered intravenously, intraarterially, intraperitoneally, intralesionally, intraarticularly, intraprostaticaly, intrapleurally, intratracheally, intravitreally, intramuscularly, intravesicularlly, intraumbilically, by injection, by infusion, by continuous infusion, by localized perfusion bathing target cells directly, or via a catheter.